

Ecological study of some physical and chemical parameters of Al-Gharraf river and one water treatment plant in Wasit province, Iraq

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دراسة بيئية لبعض العوامل الفيزيائية والكيميائية لمياه نهر الغراف واحد محطات معالجة المياه في محافظة واسط / العراق

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المستخلص

تم دراسة مجموعة من العوامل الفيزيائية والكيميائية لمياه نهر الغراف في محافظة واسط واحد محطات معالجة المياه الواقعة على نهر الغراف (محطة معالجة الكريمية) للفترة من ايار 2017 الى تشرين الاول 2017 حيث تم قياس مجموعة من العوامل البيئية مثل درجات الحرارة , العكورة , التوصيلية الكهربائية , الاملاح الذائبة الكلية في الماء , العسرة الكلية , القاعدية , الاس الهيدروجيني وتراكيز كل من (الكالسيوم , الكبريتات , المغنيسيوم , الصوديوم , البوتاسيوم و الكلورايد) لعينات من ماء النهر وماء الشرب الذي تم جمعه من محطة معالجة المياه ومقارنته مع المواصفات العراقية لمعرفة مدى ملائحته للاستخدام البشري . أظهرت نتائج الدراسة الحالية بالنسبة للماء الخام من نهر الغراف ان درجات الحرارة كانت ضمن المدى (23- 34.7) درجة مئوية , وعكورة مياه النهر تتراوح بين (35) وحدة عكورة الى (123) وحدة عكورة بينما التوصيلية الكهربائية والاملاح الذائبة الكلية كانت ضمن المدى (1018 – 1343) مايكروسيمنز و (640 – 864) ملغم/ لتر على التوالي . وكانت قيمة الاس الهيدروجيني تتراوح بين (7) الى (7.5) وتراوح قيم العسرة الكلية بين (335 الى 448) ملغم/ لتر بينما كانت تراكيز الكالسيوم والمغنيسيوم ضمن المدى (72- 115) , و (33 – 47) ملغم/ لتر على التوالي . وكانت قيم القاعدية الكلية لماء النهر تتراوح بين (158-197) ملغم/ لتر والكلوريدات (91-119) ملغم/ لتر . وكانت تراكيز كل من الكبريتات والصوديوم والبوتاسيوم تتراوح بين (200-320) , (78- 107) , (2-3) ملغم/ لتر على التوالي. وظهرت نتائج التحليل الاحصائي لمياه النهر وجود علاقة ايجابية معنوية بين العوامل البيئية المقاسة لمياه النهر .

اما بالنسبة لماء الشرب ايضا تم قياس العوامل البيئية مثل درجات الحرارة , العكورة , التوصيلية الكهربائية , الاملاح الذائبة الكلية في الماء , العسرة الكلية , القاعدية , الاس الهيدروجيني وتراكيز كل من (الكالسيوم , الكبريتات , المغنيسيوم , الصوديوم , البوتاسيوم و الكلورايد) وكانت جميعها ضمن المواصفات العراقية القياسية.

Abstract

This study was conducted to measure some of physical and chemical parameters for Al-Gharraf river water and water treatment plant (Al-Karimmia water treatment plant) in Wasit Province from May 2017 to October 2017. Ecological factors that measure included water temperature, turbidity, pH, electrical conductivity, total dissolved solid, total hardness, alkalinity and the concentrations of (Ca, Mg, SO₄, Cl, Na, K) for the samples of the raw water from river water and drinking water from water treatment plant and compared drinking water with Iraqi standards to determine its suitability for human uses. The results of this study of the raw water showed that water temperature was in the range (23-34.7°C), turbidity in the range (35-123 NTU), EC and TDS ranged between (1018-1343 µs/cm) (640-864 mg/L) respectively. The range of pH (7 to 7.5), total hardness (335 to 448 mg/L) and alkalinity (158 to 197 mg/L). The concentrations of Ca and Mg in the range (72-115 mg/L) (33-47 mg/L) respectively. The monthly concentrations of sulphate ranged between (200 -320 mg/L) while the concentration chloride (91-119 mg/L). Sodium and potassium values varied from (78-107 mg/L) (2-3 mg/L) respectively.

The physical and chemical parameters such as water temperature, turbidity, pH, electrical conductivity, total dissolved solid (TDS), total hardness, alkalinity and the concentrations of (Ca, Mg, SO₄, Cl, Na, K) were measured for drinking water and all of these agree with Iraqi standards.

Introduction

Water is very important part of life in all natural ecosystems and is consumed by all organisms and it is essential that human should get pure and clean drinking water. Simple access to safe water is an important first step to protect human health (1). Water has wide different spectrum of domestic, industrial, agricultural and other human applications (2). Water pollution is the introduction into rivers or ocean waters of chemical, physical or biological materials that change the water quality and affect the water living organisms (3). This process include simple addition of dissolved or suspended solids and persistent toxic pollutants such as; pesticides and heavy metals (3).

Water exposed to various types of pollutants such as heavy metals, pesticides, detergents and petroleum products, in addition to industrial and agricultural wastes may lead to a damage impact on public health of human (4).

Drinking water is defined as having acceptable quality in terms of physical, chemical, and biological parameters so that it can be safely used for drinking, cooking and other domestic applications (5). In Iraq drinking water comes from rivers, lakes, wells and springs. These sources are exposed to different of pollutants (6).

The water pollution of rivers required great efforts, and water quality is an important issue in the field of water resources planning and management and requires data analysis, and interpretation of data (7) . Water quality is a network of physical, chemical parameters such as temperature, total dissolved solids, electrical conductivity, pH, turbidity .. ect affect each other (8) .The lack of safe drinking water measures lead to a number of diseases such as cholera, salmonellosis and typhoid (9). So that regular examination of water quality for the presence of pathogenic organisms, chemicals and other physical parameters must be conducted to provide information on the level of the safety of water (10).

The aims of the study

1-This study was carried out to measure some physical and chemical parameters of river water (Al-Gharraf river) and drinking water from one water treatment plant (Al-Karimia water treatment plant) that located on Al-Gharraf river in Wasit province from May 2017 to October 2017 .

2-Comparing the physical and chemical parameters of drinking water with the Iraqi standard for drinking water.

3-Study the correlation between the physical and chemical parameters of the river water.

Materials and Methods

The study area

The current study included collection of water samples from Al-Gharraf river and from water treatment plant (Al-Karimmia water treatment plant) that located on Al-Gharraf river in Wasit province from May 2017 to October 2017. It passes through population and agricultural land, the main source of water for the region.

Al-Gharraf is branch of the Tigris River ,it flows from the right bank of Tigris at Al-Kut Dam to the Euphrates basin passing Wasit and Dhi-Qar governorates (11). This river has (168 Km) in length, is located in the southern province of wasit (12).

The river suffers from human and natural problems like reduction of water, the growth of plants, pollution, and accumulation of mud (11).

One water treatment plant located on the river was selected to assess the viability of drinking water and human use as well as the impact of polluting substances on the river. (Fig. 1).



Figure (1):- The location of Al-Gharraf river and Al-Karimmia treatment plant in Wasit province .

Collection of water samples

Water samples were collecting once monthly from May 2017 to October 2017 .The water samples were taken from the crude water (Al-Gharraf river) and from drinking water (from water treatment station).The physical and chemical parameters of water samples were measured monthly such as water temperature ,pH , turbidity ,electrical conductivity (EC), total dissolved solids (TDS),alkalinity, total hardness (T.H) and the concentrations of (Ca,Mg,Cl,Na,K,SO₄) for each of the raw water and the drinking water .All these measurements were implemented in Water Directorate of Wasit Governorate.

Water samples were collected for physical and chemical analysis by using clean plastic bottles (13).

Methods of measurement

1-Water quality parameters that measured in situ are explained in table (1)

Table (1):- Measurement methods for the chemical and physical parameters of water.

NO.	Parameters	Unit	Methods
1	Temperature	C ⁰	Mercury thermometer
2	Turbidity	NTU	Turbidity meter
3	pH		pH-meter
4	EC	(μS/cm)	EC-meter
5	TDS	ppm	Multi-parameters

2-Water quality parameters that measured in the laboratory

Alkalinity as CaCO₃(mg/L) was measured by using Hydrochloric acid (HCl) (titration) and methyl orange (indicator) (13).

Total hardness (mg/L) was measured by using EDTA (Ethylene diamine tetra acetic acid disodium) (titration) and Erichrom black T (indicator) (13).

Hardness as (Ca) was measured by using EDTA (Ethylene diamine tetra acetic acid disodium) (titration) and murexide (indicator). The method of measurement called Titrametric method and the results are expressed in unit of mg /L. (13).

Magnesium ion concentration was calculated according to the equation explained in (13):-

$$\text{Mg}^{+2} \left(\frac{\text{mg}}{\text{L}} \right) = [\text{T.H.} - (\text{Ca} \times 2.5)] \times 0.243$$

Chloride (Cl) was measured by using AgNO₃ Silver Nitrate (titration) and potassium chromate (K₂CrO₄) (indicator) (13).

The concentration of SO₄ was measured by using (HCl) Hydrochloric acid (Conditioning Reagent) and Barium Chloride (BaCl₂). The results are expressed in unit of mg /L. (13).

The concentrations of Sodium (Na) and potassium (K) was measured by using Flame Photometer .The results are expressed in unit of mg /L. (13).

Statistical analysis

Statistical analysis was conducted for the data using software program (SPSS). To know correlation coefficient to determine significant differences between physical and chemical parameters of water at P value of 0.01 and 0.05 .

Results and Discussion

The physical and chemical parameters of raw water and drinking water

water temperature

water temperature is an important factor in any aquatic ecosystem affecting on biological processes (14). The results of this study showed that water temperature of raw water (from Al-Gharraf river) was varied from the highest value was (34.7 Co) in August and the lowest value (23 Co) in May, with the mean (29.8Co)during the period of this study. The differences of water temperature between months were due to climate changes (15) .As shown in Table (2).

Temperature of drinking water (from water treatment plant) was the high value (33.7Co) in August and the low value (22.6 Co) in May ,with the mean (29.7Co). Water temperature affect on the rate of the river's biological and chemical processes (such as self-purification) (16). As shown in Table (2).

Turbidity

Turbidity of raw water was in range (35 in May -123 in June NTU),and the mean (65.3 NTU) as shown in Table (2). Turbidity increased in summer months, the reason of that may be due to the increase of rates of dry precipitation of the dusty storms that cause the sedimentation of addition amounts of the dusty matters to the surface water of river (2) .The changes in turbidity values depend on the water content of suspended matter in the river (17).

The highest value of turbidity of drinking water was (37 NTU) in July and the lowest value was (5 NTU) in September with the mean (17.5 NTU). The results of this study (Almost every months) were not agree with Iraqi standard for drinking water expect September was agree with Iraqi standard. Table (3).

pH

The pH values of raw water ranged from 7 to 7.5 with the mean (7.3) and this result agree with (18) recorded pH of Al-Gharraf river in the range (7-7.9), as shown in Table (2). River water tends to be alkaline, due to the natural existence of the carbonates and

bicarbonates, and that is typical for Iraqi rivers (19).

The pH values of drinking water (Al-Karimia treatment plant) were in the range (6.9 in June to 7.4 in October) and this results agree with Iraqi standard for drinking water. Table (3).

Electrical Conductivity (EC) and Total dissolved solids (TDS)

The maximum EC value of raw water was 1343 $\mu\text{S}/\text{cm}$ (in September) and the minimum EC value was 1018 $\mu\text{S}/\text{cm}$ (in June) with the mean (1210 $\mu\text{S}/\text{cm}$) as shown in Table (2).This is due to the high concentration of salts dissolved in water because increased evaporation due to high temperature, which increases the speed of movement of ions and thus increase the electrical conductivity (20).

Current results of this study showed that the highest value was 864 mg/L(in September) of TDS of raw water (Al-Gharraf river) and the lowest value was 640 mg/L (in June) of TDS. The mean of TDS of raw water was (764 mg/L) as shown in Table (2). This result agree with (21) recorded higher values of TDS of Al-Gharraf river was (545-957) mg/L .

The obtained results of EC of drinking water (Al-Karimia treatment plant) were in the range (1022 - 1328 $\mu\text{S}/\text{cm}$) and the mean of EC was 1201.8 $\mu\text{S}/\text{cm}$. These results agree with Iraqi standard for drinking water Table (3).

TDS values of drinking water were in the range (642-834 mg/L) and the

mean was (758.6 mg/L). These results agree with Iraqi standard for drinking water. Table (3).

Total Hardness

The result of this study showed that the maximum value of T.H of raw water was (448 mg/L in September) and the minimum value of T.H was (335 mg/L in June) and the mean (405 mg/L) as shown in table (2). This results agree with (21) recorded that the range of total hardness of Al-Gharraf river was (306-496 mg/L). The highest values of T.H of water river due to the agricultural, Industrial and human wastes from the nearby lands that lead to raising the rates of hardness in the water (22).

The result of this study showed that the range of total hardness of drinking water (from Al-Karimia treatment plant) was from(336 mg/L June) to (433 mg/L July) and the mean was (400.3 mg/L)). These results agree with Iraqi standard for drinking water .Table (3).

Calcium and magnesium ions

The elements often found in natural waters by the highest concentrations are calcium and magnesium (23). Calcium ion had great importance in water because the total hardness of water depended on its concentration and Calcium ion is abundant in natural water due to the melting of calcareous rocks in water. (24).

The results of raw water showed that the higher value of calcium was recorded in the July 115mg/L while the

lowest value were recorded in June 72 mg/L and the mean of Ca^{2+} was (97.3 mg/L) as shown Table(2).

The higher concentrations of total hardness and calcium ion due to increase the melting of carbon dioxide in water and the formation of carbonic acid which helps to dissolve salts Calcium in Water (25).

The concentration of calcium ion of drinking water was in the range (72-115 mg/L) with the mean (97 mg/L) and this result was agree with Iraqi standard for drinking water. Table (3).

The results of the study for raw water showed that the highest value of magnesium ion was recorded in September (47 mg/L) while the lowest concentration of magnesium ion was recorded in October (33mg/L).

while the highest value of magnesium ion of drinking water was in September (45mg/L) and the lowest value was in July (35 mg/L) and the mean was (38.8 mg/L), this result was agree with Iraqi standard for drinking water. Table (3).

Magnesium concentration is less than calcium concentration due to the nature of river sediments in Iraq (2).

Sulfate SO_4

The results of the study for raw water showed that the highest value of sulfate was recorded in October (320 mg/L) while the lowest value of sulfate was recorded in June (200 mg/L) and the mean was (266.6 mg/L) Table (2). The sulphate values recorded in this study is coincided with findings of (26),

found the sulphate value between 231-383 mg/l in Al-Gharraf river .

The Iraqi waters distinguished by the presences of a high concentration of SO₄ ions, the sulphur has a great bio important of many organism, it is one of the main elements in forming proteins and plants growth (17).

For drinking water the highest value was 320 mg/L in October and the lowest value was recorded in June (201 mg/L) and the mean was (266 mg/L).

Concerning the drinking water, there is no significant differences between the raw water and drinking water (2). The results of this study was agree with Iraqi standard for drinking water Table(3).

Chlorides (CL)

The chloride ion is available in all natural water at varying concentrations, agricultural, industrial, and domestic wastewaters discharged to surface waters are a source of chlorides (27). The high value of the chloride (Cl⁻) in this study was (119 mg/L) recorded in September while the low value was (91 mg/L) recorded in June and the mean was (106.6 mg/L)for the raw water Table(2). Higher concentrations of Cl⁻ in this study Compatible with (28) who recorded in his study Cl⁻ values were ranged between 95-160 mg/l in Al-Gharraf River. This result is coincided with (21) who recorded that the range of Cl in Al-Gharraf River was (89- 184 mg/L).

For drinking water , The maximum value of the chloride (Cl⁻) was (117

mg/L) recorded in October and the minimum value was (92 mg/L) recorded in June and the mean was (106.6 mg/L)

The results showed increase the amounts of chloride in the drinking water, that may be caused by the alum addition in which the chloride is one of the stains that are found in it (29). The results of this study was agree with Iraqi standard for drinking water Table(3).

Total Alkalinity

The cause of alkalinity is the minerals, the various ionic species that contribute to alkalinity include carbonates, bicarbonates and hydroxides of magnesium, potassium and sodium. Calcium is the most common constituent that causes alkalinity (30).

The current work has shown that the highest value of alkalinity was 197 mg/l in June while the lowest value was 158 mg/l in August and the mean (171 mg/L) for the raw water as shown in table (2). The study results showed that the river water was a light alkaline because the alkalinity recipe is common in Iraqi waters to provide bicarbonates salts in water (31).

For drinking water , The maximum value of alkalinity was (198 mg/L) recorded in June and the minimum value was (156 mg/L) recorded in May and the mean was (169mg/L). The results of total alkalinity values in this study within the range of Iraqi standards for drinking water Table (3).

Table(2):- Measurements of the physical and chemical parameters of Al-Gharraf river water and drinking water during the period of the study (May 2017 to October 2017)

Parameters Months		Temp.	Turb.	pH	E.C	TDS	Alk.	T.H	Ca	Mg	Cl	SO4	Na	K
May	crude water	23	35	7.5	1137	732	164	424	96	45	110	227	93	2.6
	drinking water	22.6	7	7.1	1133	730	156	422	96	44	110	230	93	2.5
June	crude water	31.4	123	7.2	1018	640	197	335	72	38	91	200	78	2
	drinking water	31	30	6.9	1022	642	198	336	72	38	92	201	78	2
July	crude water	32	79	7	1326	832	180	433	115	35	111	290	107	3
	drinking water	33	37	7	1328	834	180	433	115	35	112	291	107	3
August	crude water	34.7	54	7.5	1144	714	158	378	89	37	92	276	84	2.8
	drinking water	33.7	17	7.3	1145	714	160	368	92	37	94	278	83	2.7
September	crude water	31.4	42	7.3	1343	864	166	448	102	47	119	287	93	3
	drinking water	32	5	7.3	1292	832	159	431	98	45	115	276	90	2.9
October	crude water	26.4	59	7.3	1293	802	162	413	110	33	117	320	97	2.4
	drinking water	26	9	7.4	1291	800	162	412	109	34	117	320	96	2.4
The mean	crude water	29.8	65.3	7.3	1210	764	171	405	97.3	39	106.6	266.6	92	2.6
	drinking water	29.7	17.5	7.1	1201.8	758.6	169	400	97	38.8	106.6	266	91	2.5

Sodium and Potassium

The results of this study of the raw water (from Al-Gharraf river) showed that the high value of Na was (107 mg/L) recorded in July and the low value was (78 mg/L) recorded in June and the mean was (92 mg/L) Table (2). For drinking water , The high value of Na was (107 mg/L) recorded in July and the low value was (83 mg/L) recorded in August and the mean was (91mg/L). The study results showed that there is no significant differences between the raw water and drinking water for the concentrations of Na. The results of the concentrations of Na in this study was agree with Iraqi standards for drinking water. Table (3). The current study has shown that the highest value of K was 3 mg/L in July and September while the lowest value was 2 mg/L in June and the mean (2.6 mg/L) for the raw water

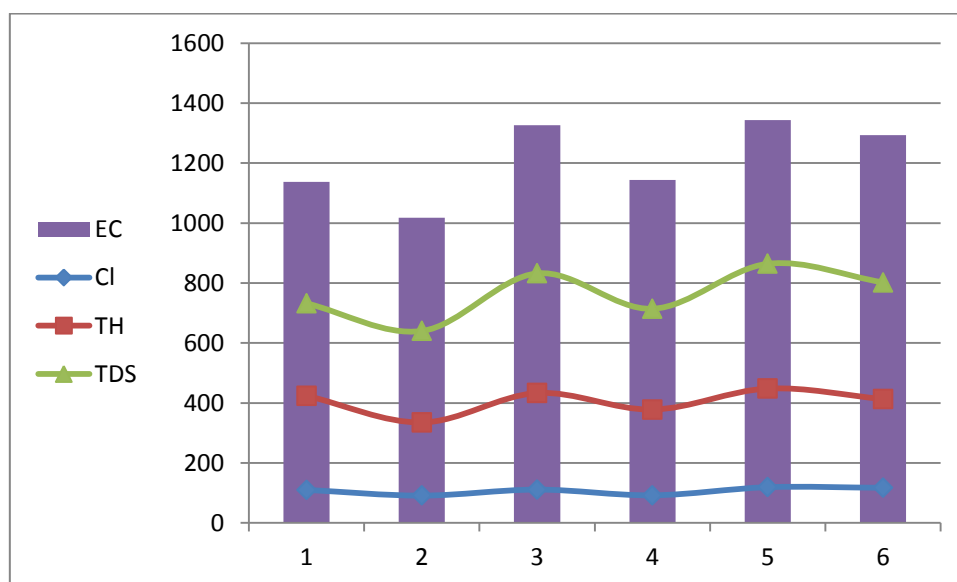
For drinking water the highest value of K was 3 mg/l in July while the lowest value was 2 mg/l in June and the mean was (2.5 mg/l). The results of this study was agree with Iraqi standard for drinking water.

Table(3):- Comparison between some water quality parameters of Al-Karimmia water plant with the Iraqi standards for drinking water

Parameters	WHO standards for drinking water in 2004	Iraqi standards for drinking water in 2001	Present study Minimum and Maximum for drinking water
pH	6.5- 8.5	6.5- 8.5	6.9 – 7.4
TDS mg/L	500-1500	1000	642 - 834
Turbidity NTU	0 -50	5	5 - 37
EC μ S.cm ⁻¹	2000	2000	1022 - 1328
T.H mg/L	100- 500	500	336 - 433
Cl ⁻ mg/L	200	250	92 - 117
SO ₄ mg/L	250	400	201 - 320
Calcium mg/L	---	150	72 - 115
Magnesium mg/L	----	50	34 – 45
Sodium mg/L		200	78 - 107
Potassium mg/L		10	2 - 3

The relationship between the physical and chemical factors of the raw water

The correlation between the studied parameters for raw water (Al-Gharraf river) showed positive significant correlation between EC and TDS , total hardness and the concentration of Cl. As shown in Fig.(2) and Table(4).

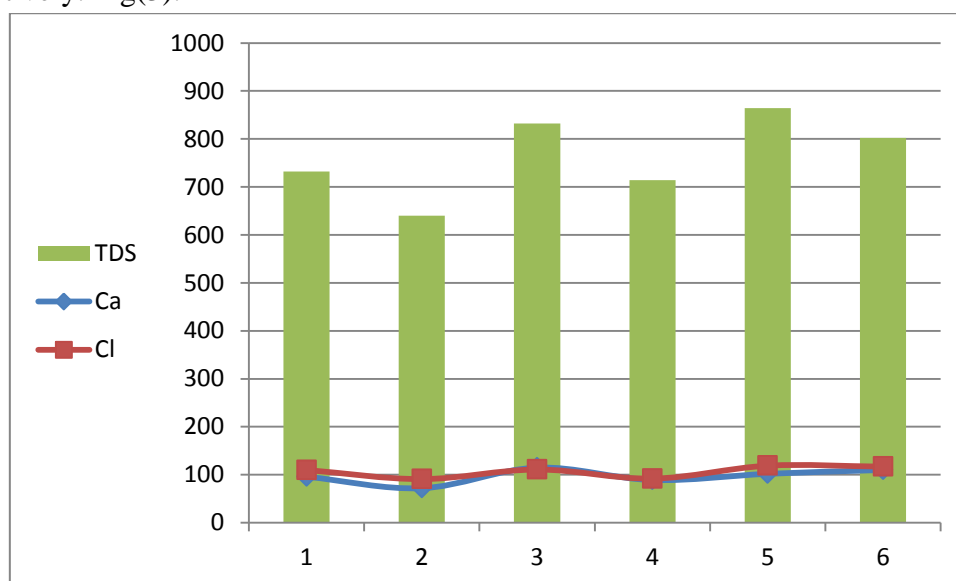
**Fig(2) :- The relationship between EC, TDS,T.H and Cl of the raw water**

The electrical conductivity is a good mark to estimation of total dissolved solids in the water and to observe the changes that occur in the aquatic environment and the elements dissolved in water (32). Also EC related to chlorides, total dissolved solids and salinity (33).

Table (4):- The relationship and the correlation factors between the physical and chemical parameters of the river water

Parameters	Temp er	Turb	pH	EC	TDS	Alk.	T.H	Ca	Mg	Cl	SO ₄	Na	K
Temp.	1	.267	-.296	.138	.000	.000	8-.13	.000	-.138	-.138	.000	-.071	.214
Turb.	.276	1.000	-.645	-.067	-.200	.467	-.333	.067	-.333	-.333	.067	.000	-.276
pH	-.296	-	1	-.215	-.215	-.645	-.072	- .358	.215	-.072	-.215	-.296	.000
EC	.138	-	-.215	1	.867*	-.067	.733*	.600	-.067	.733*	.600	.552	.690
TDS	.000	-.200	-.215	.867*	1	.067	.867*	.733*	.067	.867*	.467	.0690	.552
Alkal.	.000	.467	-.645	-.067	.067	1	.200	.067	.200	-.067	-.200	.0000	.000
T.H	-.138	-.333	-.072	.733*	.867*	.200	1	.600	.200	.733	.333	.552	.690
Ca	.000	.067	-.358	.600	.733*	.067	.600	1	-.200	.600	.733*	.966**	.414
Mg	-.138	-.333	.215	-.067	.067	.200	.200	-.200	1	-.067	-.467	-.276	.138
Cl	-	-.333	-.072	.733*	.867*	-	.733*	.600	-.067	1	.600	.552	.414
SO ₄	.000	.067	-.215	.600	.467	-.200	.333	.733*	-.467	.600	1	.690	.414
Na	-.071	.000	-.296	.552	.690	.000	.552	.966*	-.276	.552	.690	1	.357
K	.214	-.276	.000	.690	.552	.000	.690	.414	.138	.414	.414	.357	1

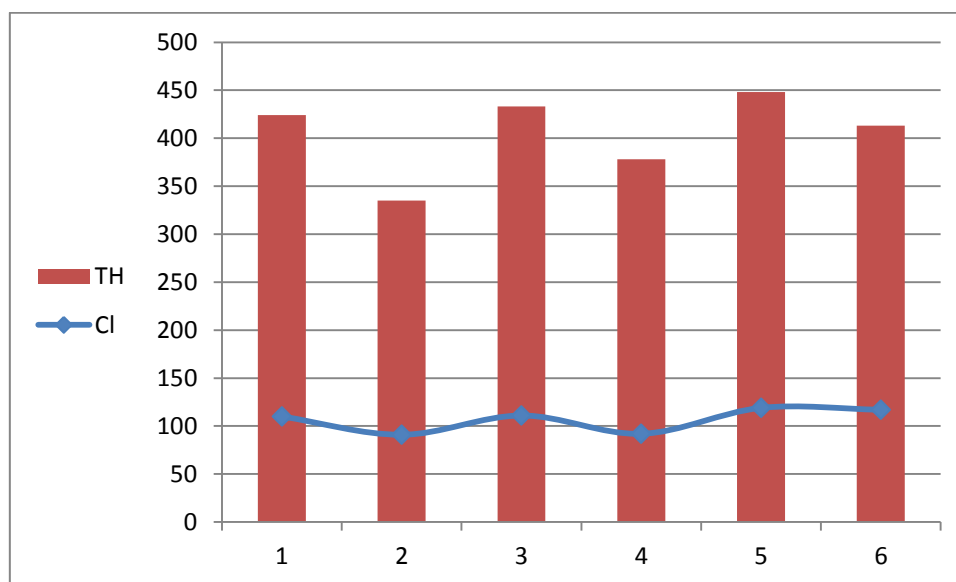
There is positive significant correlation between TDS and total hardness ($r = 0.867$) and between TDS and the concentrations of Ca and Cl at correlation factor (0.733, 0.867) respectively. Fig(3).



Fig(3) :- The relationship between TDS, Ca and Cl of the raw water

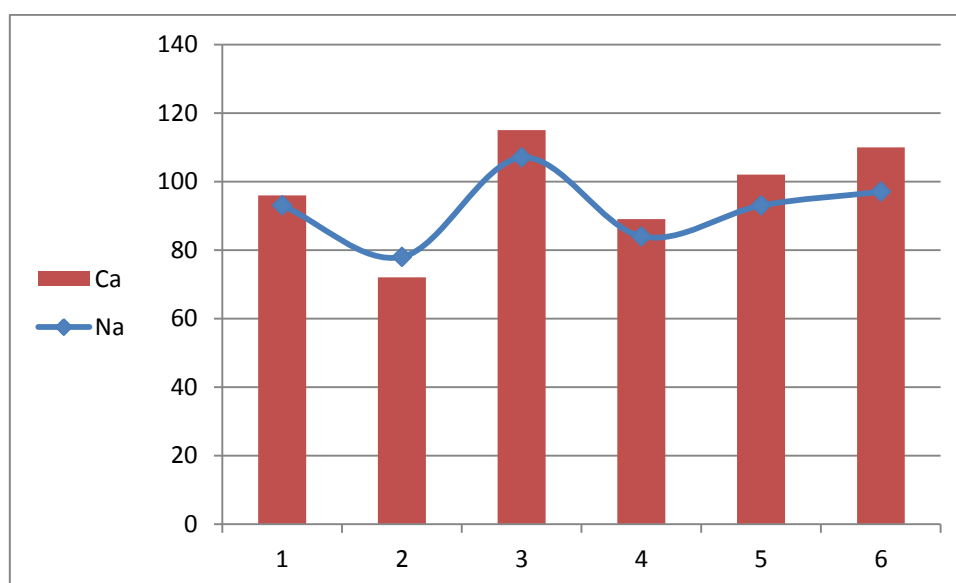
Total Dissolved Solids is a measure of the concentration of dissolved substances in water, which include chloride, sulfate, phosphate, nitrate, calcium, magnesium and sodium. (34).

The positive correlation was observed between total hardness (T.H) and the concentration of Cl ($r = 0.733$). The obtained results of this study agree with (35) who observed positive relationship between T.H and Cl in Uosifea River Water. Fig(4).

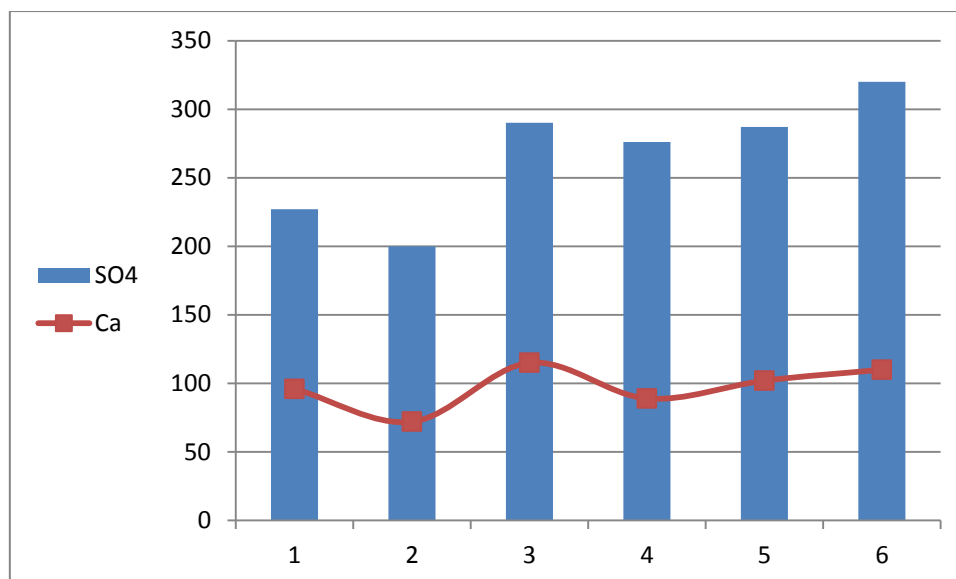


Fig(4) :- The relationship between T.H and Cl of the raw water

There is significant positive correlation between the concentration of calcium and the concentrations of sulphate (SO_4) and sodium (Na) at correlation factor (0.733 , 0.966) respectively. Fig (5) and Fig (6).



Fig(5) :- The relationship between calcium and sodium of the raw water



Fig(6) :- The relationship between calcium and sulphate of the raw water.

CONCLUSION

The results of current study indicated that the drinking water from the water treatment plant (Al-Karimmia water treatment plant) was within Iraqi standard and suitable for human use.

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